When sampling for nematodes in annual field and vegetable row crops, a sampling depth of 18 inches (45 cm) is normally adequate for estimating population numbers. In fields that have had a prolonged dry fallow period, nematodes will tend to be at deeper vertical profiles, where there is greater soil moisture; sampling down to the 3-foot (90 cm) level is desirable under these conditions. For grapevines, sampling within rows to a depth of 2½ feet (75 cm) and, for tree crops, sampling beneath the canopy to a depth of 3 feet (90 cm) are adequate for detecting parasitic nematode populations.

In relation to vertical distribution and sampling strategy, cyst nematodes present a different problem, because eggs in a cyst can remain viable and survive in dried surface soil. Surface soil sampling of the tilled soil after cultivation can provide an accurate quantitative estimate of the cyst nematode population.

At very great soil depths, the increased anaerobic conditions limit the survival of most plant parasitic nematode species; however, examples of nematodes found at great depth include *Xiphinema index,* found 6 feet below surface on grapes, and *Pratylenchus vulnus,* found 10 feet below surface around walnut roots.

Studies on the movement and migration of root knot nematodes in soil have shown that second stage juveniles of *M. incognita* can move over a distance of greater than 3 feet (90 cm) in either direction in the vertical plane. Downward movement over this distance could be important in terms of following retreating moisture gradients during drying soil conditions, such as fallow periods, and the upward migration of nematodes over this distance may partly explain the rapid reinfestation and infection of plants grown in soil following fumigation treatments.

Common Nematode-Crop Damage Associations

The list of nematode-crop damage associations in table 1 is the result of the effort of a university-industry committee, led by B. F. Lownsbery of the University of California at Davis. The listing provides an indication of the nematodes most likely to be associated with damage of selected California crops.

TABLE 1. NEMATODE SPECIES APT TO BE IMPORTANT FACTORS LIMITING CROP GROWTH IN CALIFORNIA (LISTED BY CROPS)

Deciduous fruits

apple—*Pratylenchus penetrans, P. vulnus, Meloidogyne* spp. *Xiphinema americanum,* a ringspot virus vector

apricot—*Pratylenchus vulnus, Xiphinema americanum,* a virus vector

cherry—*Pratylenchus penetrans, P. vulnus, Xiphinema americanum,* a ringspot virus vector. *Paratylenchus* spp. are also common on cherry. Their effects on cherry have not been studied.

peach and nectarine—*Meloidogyne incognita, M. javanica* (root knot nematode resistant rootstocks available), *Criconemella xenoplax, Pratylenchus vulnus, Xiphinema americanum,* a ringspot virus vector. *Pratylenchus* spp. and *Trichodorus* or *Paratrichodorus* spp. are sometimes associated with poor growth of peach, but their effects on peach have not been studied in controlled experiments.

pear—*Paratylenchus* spp., *Helicotylenchus* spp., *Xiphinema americanum, Pratylenchus vulnus* and other *Pratylenchus* species have been found commonly in surveys of pear orchards. Evidence to date suggests that pears are pretty tolerant of these nematodes.

persimmon—*Tylenchulus semipenetrans*

plum and prune—*Pratylenchus vulnus, Paratylenchus neoamblycephalus, Criconemella xenoplax, Xiphinema americanum,* a ringspot virus vector

Nuts

almond—*Meloidogyne incognita, M. javanica* (peach rootstocks resistant to root knot nematodes may be used), *Xiphinema americanum,* a ringspot virus vector

pistachio—*Pistachia vera* susceptible to *Meloidogyne* spp. *P. atlantica, P. terebinthus,* and *P. integerrima* resistant to all *Meloidogyne* spp. *X. americanum* and *P. hamatus* develop in fields.

walnut—*Pratylenchus vulnus, Criconemella xenoplax, Meloidogyne* spp.

Citrus fruits

The principal nematode pathogen on all the citrus fruits is *Tylenchulus semipenetrans.*

Subtropical fruits other than citrus

avocado—*Pratylenchus vulnus*

fig—*Pratylenchus vulnus, Meloidogyne incognita,* and *M. javanica*

olive—*Pratylenchus vulnus, Tylenchulus semipenetrans, Meloidogyne incognita, M. javanica*

Grapes and small fruits

grapes—*Meloidogyne incognita, M. javanica, Pratylenchus vulnus, Xiphinema index, X. americanum (X. californicum), Paratrichodorus minor, Tylenchulus semipenetrans, Criconemella xenoplax*

blackberries and relatives—*Pratylenchus vulnus*

continued next page

TABLE 1. Continued

Grapes and small fruits, *continued*

raspberries—*Pratylenchus vulnus, Xiphinema americanum*

strawberries—*Pratylenchus penetrans, P. vulnus, Aphelenchoides fragariae, A. ritzemabosi, Meloidogyne hapla, Xiphinema americanum*

Vegetables

artichokes—*Merlinius brevidens* is found commonly around artichoke. Its effect on artichoke has not been studied.

asparagus—*Meloidogyne incognita*

carrot—*Meloidogyne arenaria, M. hapla, M. incognita*

lima bean—*Meloidogyne incognita, M. javanica*

snap beans—*Meloidogyne incognita, Pratylenchus scribneri*

table beets—*Heterodera schachtii, Meloidogyne hapla, M. incognita, M. javanica*

cabbage, brussels sprouts, broccoli, cauliflower—*Heterodera schachtii, H. cruciferae, Meloidogyne hapla, M. incognita, M. javanica*

cantaloupes, watermelons, other melons, pumpkins—*Meloidogyne incognita, M. javanica*

celery—*Meloidogyne hapla, M. incognita,* when growing season extends into warm weather

corn—*Paratrichodorus minor, Meloidogyne* spp. *Helicotylenchus* spp., *Merlinius brevidens, Pratylenchus minyus,* and *Tylenchorhynchus* spp. are also associated with corn in California. Their effects on corn in California have not been studied.

blackeye beans—*Pratylenchus scribneri, Meloidogyne incognita*

cucumbers and pickles—*Meloidogyne incognita, M. javanica*

eggplant—*Meloidogyne incognita, M. javanica*

endive and chicory—*Meloidogyne incognita, M. javanica*

lettuce—*Meloidogyne hapla, M. incognita, M. javanica, Longidorus africanus. Merlinius brevidens* is found commonly around lettuce. Its effect on lettuce has not been studied.

garlic and onions—*Ditylenchus dipsaci, Meloidogyne hapla, M. incognita, M. javanica*

garden peas—*Heterodera trifolii*

parsnips—*Meloidogyne incognita*

peppers—*Meloidogyne incognita, M. javanica, Paratrichodorus minor*

irish potatoes—*Meloidogyne hapla, M. chitwoodi, M. incognita, M. javanica, Paratrichodorus minor* (a vector of corky ringspot virus)

sweet potato—*Meloidogyne incognita*

radish—*Heterodera schachtii, Meloidogyne incognita*

spinach—*Heterodera schachtii, Meloidogyne incognita*

squash—*Meloidogyne incognita, M. javanica*

tomato—*Meloidogyne hapla, M. incognita, M. javanica.* Some tomato varieties are resistant.

turnips—*Heterodera schachtii*

Seeds and grain

alfalfa—*Ditylenchus dipsaci, Meloidogyne hapla, M. javanica, Tylenchorhynchus clarus, Paratrichodorus minor. Merlinius brevidens, Helicotylenchus* spp., *Xiphinema americanum* and *Pratylenchus* spp. are also associated with alfalfa. Only *M. hapla* and *D. dipsaci* are shown to be pathogenic in central California.

Seeds and grain, *continued*

barley—*Meloidogyne naasi. M. chitwoodi,* and *Merlinius brevidens* are also associated with barley. Their effect has not been studied.

dried beans (lima, blackeye, kidney, garbanza)—*Meloidogyne incognita, M. javanica, Pratylenchus scribneri.* Other nematodes associated with dried beans include *Tylenchorhynchus clarus, Paratrichodorus minor,* and *Paratylenchus* spp. Their effects on beans have not been studied.

bermudagrass (for seed)—A number of nematode species are associated with bermudagrass, most commonly *Helicotylenchus dihystera, Meloidogyne* spp. and *Tylenchorhynchus clarus,* but their pathogenicity to bermudagrass has not been proven.

clover (Alsike, Ladino, Red, White)—*Heterodera trifolii, Meloidogyne hapla, M. incognita, M. javanica*

oats—*Meloidogyne naasi, M. chitwoodi,* and *Merlinius brevidens* are also associated with oats in California. Their effect on oats is not known.

rye—*Meloidogyne naasi*

rice—*Hirschmanniella belli* occurs on rice in California. It has not been associated with poor growth of rice, however.

sorghum—*Pratylenchus minyus, P. thornei,* and *Merlinius brevidens* are associated with sorghum in California. Their effects on sorghum are not known.

wheat—*Meloidogyne naasi, M. chitwoodi* and *Merlinius brevidens, Pratylenchus thornei. P. minyus* is also associated with wheat. Their effects have not been studied.

Fiber and sugar crops

cotton—*Meloidogyne incognita, Paratrichodorus minor, Pratylenchus brachyurus. Helicotylenchus* spp. and *Tylenchorhynchus clarus* commonly associated with cotton. Their effects on cotton have not been studied.

sugarbeet—*Heterodera schachtii, Meloidogyne hapla, M. incognita, M. javanica, Ditylenchus dipsaci, Paratrichodorus* spp.

Ornamentals

abelia—*Meloidogyne hapla*

African violet—*Aphelenchoides fragariae, A. ritzemabosi*

ajuga—*Meloidogyne hapla, M. incognita*

anthurium—*Helicotylenchus* spp., *Paratylenchus* spp., *Scutellonema* spp. In addition, *Radopholus similis* is sometimes found on anthurium shipped into California.

arrowroot—*Meloidogyne incognita, Pratylenchus penetrans.* In addition, *Radopholus similis* is sometimes found on arrowroot shipped into California.

azaleas—*Tylenchorhynchus claytoni*

banana—*Meloidogyne incognita, Helicotylenchus* spp., *Scutellonema brachyurum, Radopholus similis*

birds-nest fern—*Aphelenchoides fragariae*

boxwood—*Pratylenchus vulnus, Meloidogyne* spp., *Rotylenchus buxophilus*

cacti—*Meloidogyne hapla, M. incognita, M. javanica, Heterodera cacti*

continued

TABLE 1. Continued

Ornamentals, *continued*

caladium—*Meloidogyne incognita, M. javanica*

calla—*Meloidogyne* spp.

camellia—*Helicotylenchus erythrina, Hemicriconemoides* sp., *Tylenchorhynchus claytoni*

canna—*Meloidogyne incognita, M. javanica, Pratylenchus penetrans*

carnation—*Criconemoides curvatum, Meloidogyne hapla, Paratylenchus dianthus, Rotylenchus robustus*

chrysanthemum—*Aphelenchoides ritzemabosi, Pratylenchus coffeae, Pratylenchus penetrans*

dahlia—*Meloidogyne incognita, Pratylenchus coffeae, P. penetrans*

dichondra—*Meloidogyne incognita, M. javanica, Helicotylenchus* spp.

dieffenbachia—*Meloidogyne incognita*

English daisies—*Meloidogyne hapla, M. javanica*

fibrous begonias—*Aphelenchoides ritzemabosi*

gardenia—*Meloidogyne incognita*

ginger—*Meloidogyne javanica.* Ginger shipped into California is often infected with *Radopholus similis*

gladiolus—*Meloidogyne incognita*

gloxinia—*Aphelenchoides ritzemabosi*

iris—*Ditylenchus destructor, Meloidogyne hapla, M. javanica, P. penetrans*

lilac—*Pratylenchus vulnus, Meloidogyne* spp.

lilies (Easter and other)—*Aphelenchoides fragariae, Pratylenchus penetrans, Meloidogyne* spp.

narcissus—*Ditylenchus dipsaci, Pratylenchus penetrans*

nephthytis—*Meloidogyne incognita*

orchids—*Pratylenchus scribneri*

palm trees—*Helicotylenchus* spp., *Meloidogyne* spp.

peperomia—*Aphelenchoides ritzemabosi*

philodendron—*Meloidogyne* spp., *Radopholus similis*

phlox—*Ditylenchus dipsaci*

pinks—*Meloidogyne incognita, Pratylenchus* spp.

true ferns—*Aphelenchoides fragariae*

primula—*Ditylenchus dipsaci*

rhododendron—*Tylenchorhynchus claytoni, Helicotylenchus erythrinae, Paratrichodorus minor*

rose—*Meloidogyne hapla, Pratylenchus vulnus*

rubberplant—*Heterodera fici*

sansaveria—*Scutellonema brachyurum, Radopholus similis, Meloidogyne* spp.

Shasta daisies—*Meloidogyne hapla*

strelitzia—*Meloidogyne* spp., *Scutellonema brachyurum, Helicotylenchus* spp.

vinca—*Meloidogyne hapla, M. javanica*

yucca—*Meloidogyne* spp., *Rotylenchulus reniformis*